

Number Theory for Algebra  
Exponents  
Rational Numbers  
Signed Number Operations  
Ratio and Proportion  
Variables and Expressions  
Equations and Formulas  
Data and Probability  
Proportional Reasoning  
Patterns  
The Coordinate Plane  
Inequalities

**Aim for Algebra**  
**Not business as usual.**

Presentation by Mardi Gale  
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## Interactive Format

Quick polling  
Open responses  
Breaks for responding to chat questions & comments  
Participants on just the teleconference can email questions to:  
[eventquestion@wested.org](mailto:eventquestion@wested.org)

## Handout

Throughout the presentation, we will be referring to a handout that can be downloaded from the SchoolsMovingUp website.

This handout will provide improved images of slides included in the Power Point presentation.

## Who is in this webinar?

Site or district administrator  
Teacher (classroom or resource)  
Secondary mathematics teacher  
EL coordinator  
Community member  
Higher education staff  
SEA staff  
Other (type in the chat area)

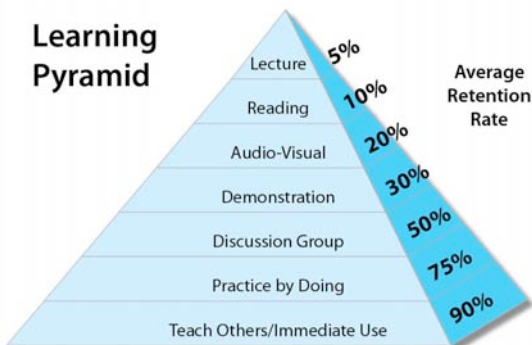


"Frank was never any good at arithmetic. He left a third of his money to me, a third to you, a third to Cindy, and a third to Matt."

High achieving students spend more time on concepts and applications and cover more topics.

Students working below grade level receive curriculum heavy on review and drill with a minimum amount of new content.

### Learning Pyramid



National Training Laboratories, Bethel, Maine

### Effective Universal Access Strategies

#### Connect to prior knowledge

- Graphic organizers
- Concept webs
- Show-and-tell
- Asking questions
- K-W-L (what you know, what you want to know, what you have learned)

#### Hands-on experiences

- Manipulatives
- Body language — pantomime, role play
- TPR (Total Physical Response)

#### Visuals

- Graphic organizer
- Modeling and demonstration
- Using physical models
- Tableau (students interpret from text)

#### Preview new vocabulary

- Word Wall
- Picture Dictionary

#### Comprehensible input

- Linking to familiar contexts
- Instructing in small groups
- Using language effectively: intonation, pauses, rephrases, repetition, simplified vocabulary, familiar vocabulary
- Use consistent language when writing word problems

#### Small group interaction

- Pairs/groups cooperative activities
- Peer questioning
- Jigsaw activities

#### Low anxiety environment

- Positive reinforcement
- Students use L1 (primary language)

## Which way?



## Poll: Intervention Curriculum

Does your school have an algebra intervention curriculum?

Yes or No?

## Essential Elements

- Targeted, not comprehensive **CURRICULUM**
- **CONCEPTUALLY** based and standards **ALIGNED**
- **FLEXIBLE** format and structure
- Embedded **INSTRUCTION**
- Purposeful **task DEVELOPMENT**
- Precise, **academic LANGUAGE** and concrete **MODELS**
- **ASSESSMENT**, pre/post and embedded
- Facilitator guides for **instructor SUPPORT**

**Aim for Algebra** was developed at **WestEd** by experts in the field of mathematics education.

The program is a **coherent** set of materials, **conceptual** in nature, rather than a collection of individual worksheets on isolated topics.

Our curriculum focuses on key **“trouble spots”** in algebra that typically cause difficulty because:

- students lack prerequisites,
- students have misconceptions about the content, or
- the material is complex and students need more time and practice with the topic.

Aim for Algebra is a standards-aligned, concept-based support curriculum developed by WestEd with funding from the **U.S. Department of Education’s Institute of Education Sciences** under PR/Award #R305K040003.

## Essential Elements

- Targeted, not comprehensive CURRICULUM

## Modules

### Available Now

Signed Number Operations

Variables and Expressions

Ratio and Proportion

Patterns

The Coordinate Plane

Inequalities

### Available Soon

Number Theory for Algebra

Exponents

Rational Numbers

Equations and Formulas

Proportional Reasoning

Data and Probability

## Essential Elements

- Targeted, not comprehensive CURRICULUM
- CONCEPTUALLY based and standards ALIGNED

Think about what a student might do to find this result:

$$28 \div 7 = 13$$

$28 \div 7 = 13$

Check your answer

$$\begin{array}{r} 13 \\ 7 \overline{)28} \\ \underline{-7} \\ 21 \\ \underline{-21} \\ 0 \end{array}$$

$$\begin{array}{r} 13 \\ \times 7 \\ \hline 21 \\ 70 \\ \hline 28 \end{array}$$

Check #2:

$$\begin{array}{r} (13) \\ (13) \\ (13) \\ (13) \\ (13) \\ (13) \\ + (13) \\ \hline (21) \\ + (7) \\ \hline 28 \end{array}$$

### 47 + 29

Add 47 and 29 mentally  
(no paper and pencil).

Think about what strategy you use.

$47 + 29$

$$\begin{array}{r} 29 + 1 = 30 \\ + 47 \\ \hline 77 \\ - 1 \\ \hline 76 \end{array}$$

$$\begin{array}{r} 47 + 3 = 50 \\ 29 + 1 = 30 \\ \hline 80 \\ - 4 \\ \hline 76 \end{array}$$

$$\begin{array}{r} 40 + 20 = 60 \\ 7 + 9 = 16 \\ \hline 76 \end{array}$$

$47 + 29$

$$\begin{array}{r} 10 \\ 47 \\ + 29 \\ \hline 6 \end{array}$$

$$\begin{array}{r} 40 + 7 \\ 20 + 9 \\ \hline 60 + 16 \end{array}$$

## 47 - 29

Subtract 29 from 47 mentally.  
Think about what strategy you use.

$$47 - 29$$

$$\begin{array}{r} 31 \\ 47 \\ - 29 \\ \hline 18 \end{array}$$

$$\begin{array}{r} 40 + 7 = 47 \\ - (20 + 9 = 29) \\ \hline 20 - 2 = 18 \end{array}$$

## 47 x 29

Multiply 47 and 29 mentally.  
Think about what strategy you use.

$$47 \times 29$$

	40	7
20	800	140
+		
9	360	63

$$\begin{array}{r} 40 + 7 \\ \times (20 + 9) \\ \hline 800 + 63 \\ 360 + 140 \end{array}$$

$$(40 + 7)(20 + 9) = 800 + 360 + 140 + 63$$
$$(x + 3)(x + 5)$$

## Poll

Do you have any questions or comments about the information presented so far?

### SIGNED NUMBER OPERATIONS

SECTION	KEY CONCEPTS/INCLUDE	CCSS IDENTIFIERS
1a	Identify and compare real numbers on number lines	HS-N.1.A.1.A.1 HS-N.1.A.1.A.2 HS-N.1.A.1.A.3 HS-N.1.A.1.A.4
1b	Understand density and compare absolute value	HS-N.1.A.1.A.1 HS-N.1.A.1.A.2 HS-N.1.A.1.A.3 HS-N.1.A.1.A.4 HS-N.1.A.1.A.5
2a	Use real number operations to solve problems involving signed numbers	HS-N.1.A.1.B.1 HS-N.1.A.1.B.2 HS-N.1.A.1.B.3 HS-N.1.A.1.B.4 HS-N.1.A.1.B.5
2b	Use real number operations to solve problems involving signed numbers	HS-N.1.A.1.B.1 HS-N.1.A.1.B.2 HS-N.1.A.1.B.3 HS-N.1.A.1.B.4 HS-N.1.A.1.B.5
2c	Use real number operations to solve problems involving signed numbers	HS-N.1.A.1.B.1 HS-N.1.A.1.B.2 HS-N.1.A.1.B.3 HS-N.1.A.1.B.4 HS-N.1.A.1.B.5
2d	Use real number operations to solve problems involving signed numbers	HS-N.1.A.1.B.1 HS-N.1.A.1.B.2 HS-N.1.A.1.B.3 HS-N.1.A.1.B.4 HS-N.1.A.1.B.5
3a	Apply knowledge of operations of signed numbers to contextual situations and games	HS-N.1.A.1.B.1 HS-N.1.A.1.B.2 HS-N.1.A.1.B.3 HS-N.1.A.1.B.4 HS-N.1.A.1.B.5

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- FLEXIBLE format and structure

## Poll: Challenges

What are some of the challenges as you consider implementing an algebra intervention program?





**AFTERNOON SNACKS**

Ben and Arian each bought the same items at the snack store.

Ben bought the total cost should be \$28.00. Arian bought the total cost should be \$18.00.

Ben bought: 2 snack bars, 3 fruit drinks, 4 fruit smoothies, 2 snack bars.

Arian bought: 3 snack bars, 4 fruit drinks, 2 fruit smoothies, 4 snack bars.

Ben's calculation:  $2 \cdot 3 + 4 \cdot 2 = 10$

Arian's calculation:  $2 \cdot 3 + 4 \cdot 2 = 10$

1. Who was correct? Explain why the answer was correct.

2. What error did the other person make?

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- Embedded INSTRUCTION
- Purposeful task DEVELOPMENT

**Seats at the Table**

Maria wants to know how many people for can seat around a row of trapezoidal shaped tables.

She started by drawing the sketches below. Then she made a chart.

1 table = 8 people  
 2 tables = 10 people  
 3 tables = 12 people  
 4 tables = 14 people

Help Maria by answering the following questions. Use what you've learned about sequences and the recursive rule.

1. Complete Maria's chart.

Number of tables in a row	1	2	3	4	5	6	7	8
Number of people seated	8							

2. Maria says that for can seat 42 people around 13 tables. Is he correct? How do you know?

Take a few minutes to work on this activity sheet in your handout packet.

**Seats at the Table**

Maria wants to know how many people for can seat around a row of trapezoidal shaped tables.

She started by drawing the sketches below. Then she made a chart.

1 table = 8 people  
 2 tables = 10 people  
 3 tables = 12 people  
 4 tables = 14 people

How does the number of tables relate to the number of addends of 3?

$2 + 3t$

Number of tables

Help Maria by answering the following questions. Use what you've learned about sequences and the recursive rule.

1. Complete Maria's chart.

Number of tables in a row	1	2	3	4	5	6	7	8
Number of people seated	8							

2. Maria says that for can seat 42 people around 13 tables. Is he correct? How do you know?

Now how does the number of tables relate to the number of addends of 3?

$$5 + 3(t - 1)$$

Number of tables less 1

**Seats at the Table**

Maria wants to know how many people for can eat around a row of tapered shaped tables.

She started by drawing the sketches below. Then she made a chart.

1 table = 5 people  
 2 tables = 8 people  
 3 tables = 11 people  
 4 tables = 14 people

Help Maria by answering the following questions. Use what you've learned about sequences and the recursive rule.

1. Complete Maria's chart:

Number of tables in a row	1	2	3	4	5	6	7	8
Number of people seated	5							

2. Maria says that for can seat 42 people around 13 tables. Is he correct? \_\_\_\_\_  
 How do you know? \_\_\_\_\_

3. Without drawing the tables, tell how many people can sit around 13 tables. \_\_\_\_\_  
 How do you know? \_\_\_\_\_

Now how does the number of tables relate to the number of addends of 3?

$$4 + 4 + 3(t - 2)$$

Number of tables less 2

**Seats at the Table**

Maria wants to know how many people for can eat around a row of tapered shaped tables.

She started by drawing the sketches below. Then she made a chart.

2 tables = 8 people  
 3 tables = 11 people  
 4 tables = 14 people  
 5 tables = 17 people

Help Maria by answering the following questions. Use what you've learned about sequences and the recursive rule.

1. Complete Maria's chart:

Number of tables in a row	1	2	3	4	5	6	7	8
Number of people seated		8						

2. Maria says that for can seat 42 people around 13 tables. Is he correct? \_\_\_\_\_  
 How do you know? \_\_\_\_\_

3. Without drawing the tables, tell how many people can sit around 13 tables. \_\_\_\_\_  
 How do you know? \_\_\_\_\_

Different ways students describe how the pattern grows:

$$2 + 3t \qquad 4 + 4 + 3(t - 2)$$

$$3t + 2 \qquad 8 + 3(t - 2)$$

$$5 + 3(t - 1) \qquad 5t - 2(t - 1)$$

Reconcile

**The Zero Case**

A useful strategy for finding the explicit rule for a pattern is to find the "zero case." The zero case is found by observing the output value when the input value is 0. Consider the table, and then answer the 3 related questions below.

Input (x)	0	1	2	3	4
Output (y)		5	8	11	14

1. What is the output value corresponding to an input of 0? \_\_\_\_\_  
 How do you know? \_\_\_\_\_

2. What is the recursive rule for the output value? \_\_\_\_\_  
 How do you know? \_\_\_\_\_

For the zero case, use the recursive rule to work backward from the output value to the input value to find the input value for output value 5.

3. What is the output value for 0? \_\_\_\_\_  
 How do you know? \_\_\_\_\_

No, when x (input) is 0, y (output) is 5, and when x is 1, y is 8, and so on. The output value for the zero case tells us the constant term of the explicit rule.

How do I know the address for each input value. Using the recursive rule helps us know the input rule for this pattern that will determine the output for any input in the pattern. We can write the table vertically to show the behavior of the recursive rule.

Input (n)	Output (f)	Recursive Rule	Initial Value
0	2	$f(n) = f(n-1) + 2$	2
1	4		
2	6		
3	8		
4	10		
5	12		

How many addends of 2 are there for each of \_\_\_\_\_  
 for each of \_\_\_\_\_  
 for each of \_\_\_\_\_

2. Fill in the table above for input values 3 and 6.  
 3. What is the relationship between the term number, input and the number of addends of 2 for the corresponding term above?

The explicit rule for this pattern is:  
 The output value is input to 2, plus the quantity "2" times the input value.  
 An equation to describe the rule is:  
 $f(n) = 2n + 2$  or  $y = 2x + 2$  or  $y = 2x + 2$

The strategy of building the staircase to help find the explicit rule is useful in identifying patterns, but it does not have meaning for some patterns that describe real objects, shapes, or situations.

Now, back to the "why" question of the task. The task asks you to explain why the recursive rule works for this pattern.

**NUMBER TILES**

The size of the square is the same as the side length of the shaded square.

Size 1    Size 2    Size 3    Size 4

Both show the patterns above. Small white tiles surround shaded squares. The shaded squares have different side lengths. Then for each table on the right.

- Fill in the empty boxes in Bob's table.
- Bob thinks that he will need a total of 100 tiles to surround a shaded square with side length of 12 inches. Is Bob correct? How do you know?
- How many small white squares are needed to surround a shaded square with side length of 12?
- Write the rule describing how you determined the correct number of squares for size 12, in words and an algebraic equation. Refer to the geometric figures in your explanation of your rule.

Length of Side of Shaded Square (s)	Number of Small White Squares (w)
1	8
2	12
3	16
4	
5	
6	
7	

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- Embedded INSTRUCTION
- Purposeful task DEVELOPMENT
- Precise, academic LANGUAGE and concrete MODELS

## Poll:

### Which is the largest number?

4

-7

### A Symbol With Different Meanings

The "+" symbol can take on different meanings in mathematics depending on how it is used. Fill in the chart below with one of your own examples, and then describe each expression in words.

The "+" symbol may tell you a number is less than zero for the number that follows the symbol is negative.

symbol	example of what we see
-7	
-63	
negative one	

The "+" symbol may mean the opposite of the quantity that follows.

-9 + 25	
+	
-8	

The "+" symbol may mean the operation of addition.

11 + 8	
4 + 5	

### A Symbol With Different Meanings

The "-" symbol can take on different meanings in mathematics depending on how it is used. Fill in the chart below with one of your own examples, and then describe each expression in words.

The "-" symbol may tell you a number is less than zero for the number that follows the symbol is negative.

symbol	example of what we see
-7	"negative seven" or "less than ten"
-63	"negative six three" or "less than ten"
negative one	"negative one" or "less than ten"

The "-" symbol may mean the opposite of the quantity that follows.

-9 + 25	"the opposite of the quantity 9 + 25"
-	"the opposite of 25"
-8	"the opposite of eight"
negative one	"the opposite of 1"

The "-" symbol may mean the operation of subtraction.

11 - 8	"11 minus eight" or "11 less than 8"
4 - 5	"4 less than 5" or "4 minus five" or "4 subtract from 5"
negative one	"1 minus 2" or "1 less than 2" or "1 subtract from 2"

### Express Your Age

- What is your age now? \_\_\_\_\_
- How old will you be ten years from now? \_\_\_\_\_
- How old will you be ten years from now? \_\_\_\_\_
- What is ten years ago? \_\_\_\_\_
- What is half your age? \_\_\_\_\_
- In how many years will you be 50? \_\_\_\_\_

### Nora and Max

What if we don't know someone's age and want to ask some questions? Let us represent Nora's present age in years.

**EXAMPLE**

- What is Nora's age now?  $n$
- How old will Nora be ten years from now?  $n + 10$
- How old will she be ten years from now? \_\_\_\_\_

**NOTE**  
How are people in the world? **ASSUME!**

- What is ten years ago? \_\_\_\_\_
- How old will Nora be ten years from now? \_\_\_\_\_
- In how many years will she be 50 years old? \_\_\_\_\_

Let us represent Max's present age in years.

**EXAMPLE**

- What is the sum of Nora's and Max's ages now?  $n + m$
- What is the sum of Nora's and Max's ages ten years from now? \_\_\_\_\_

### A Mathematical Model

An algebraic expression which represents a real world situation is a "mathematical model." A mathematical model can help show how a situation changes for different values of the variables.

Here is an example of a mathematical model from Camp Splash:  
Let  $F$  = number of 2-person tents  
 $F$  = number of 4-person tents

The algebraic expression  $2F + 4F$  is a mathematical model that represents the total number of people who can sleep in the tents.

1. Complete steps 1 and 2 of the model.

2. Complete step 3 and 4 of the model.

\*\*\*

Fill in the blanks for the following questions about the expression  $2x + 4x$ .

- The first term  $2x$  represents the total number of \_\_\_\_\_ in the \_\_\_\_\_-person tents.
- The second term \_\_\_\_\_ represents \_\_\_\_\_.
- The numerical coefficient of the first term  $2$  indicates \_\_\_\_\_ per \_\_\_\_\_-person tent.
- The numerical coefficient of the second term \_\_\_\_\_ indicates \_\_\_\_\_.

**Why it Works**

We can use algebra to show why the number game on page 1 works for any number you choose.

Let the variable  $x$  represent any number.

Steps	Algebraic Notation
1. Pick any number	$x$
2. Subtract 2	$x - 2$
3. Multiply by 3 Simplify using the Distributive Property	$3(x - 2)$ $3x - 6$
4. Add 15 Simplify by combining like terms	$3x - 6 + 15$ $3x + 9$
5. Divide by 3 Simplify using the inverse of the Distributive Property	$\frac{3x + 9}{3}$ $\frac{3x}{3} + \frac{9}{3}$ $x + 3$
6. Subtract the original number Simplify	$x + 3 - x$ $3$

What is your final amount?

**Poll:**

## Precise Language

How do you see precise language and modeling reflected in the programs in your mathematics classrooms?

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- **ASSESSMENT**, pre/post and embedded

**Poll:**

How could you correctly answer this question without knowing what perimeter is?


◆ A typical geometry test question today:

Find the perimeter.

3 5 2  
4 3 6 3

♦ A problem that gives a better indication of a student's knowledge of perimeter is:

**Draw a six-sided irregular polygon with a perimeter of 23 units. Show all dimensions.**




## Sources of Assessment Items

- Linked directly to instruction
- Includes items from national exams, such as NAEP and TIMSS
- Includes items adapted from state standard exams and state exit exams

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SEATY AT THE TABLE (ADAPTED FROM NAEP)	FACILITATOR GUIDE
<p><b>PURPOSE:</b> Apply understanding of recursive rules and patterns using geometric representations.</p> <p>This task may serve as a formative assessment.</p> <p><b>LAUNCH:</b> Before giving students the item to work on:</p> <ul style="list-style-type: none"> <li>• Ask students if they can think of situations where they might need to arrange tables to maximize seating. For example, party planning, planning for family meals at Thanksgiving or during the holiday season, or event planning.</li> <li>• Discuss how they would divide the table arrangements.</li> <li>• Draw the first picture on the overhead/board or use pattern blocks to show the recursive rule of one table.</li> <li>• Establish the way in which people sit at the tables. That is, 1 person on each end, 1 on the short side, and 2 on the long side.</li> <li>• Draw model putting a second table on the overhead, or show or sketch the second picture from the task.</li> <li>• Discuss where people can sit so that the tables have been pushed together. Remind them that the rule for adding tables is that they connect end to end, not sides.</li> <li>• Read the questions together to be sure students understand the questions asked before students complete the items.</li> <li>• Students may work on the items independently.</li> </ul> <p><b>Summary:</b></p> <ul style="list-style-type: none"> <li>• Ask students to share their responses. Accept many different explanations for item 5.</li> <li>• Ask students to use the diagram to explain their solution. That is, explain their response in terms of the pattern. (When another table is added, two of the ends are no longer available, but the person on one end is now sitting at the end of the new table and each time a table is added, 4 more people can sit with the groups - circle the 3 people.)</li> <li>• Ask students to make the connection between the diagram, the tables at the right of the diagram, and the table in item 1. (They all represent the same pattern, but are displayed in different formats.)</li> </ul> <p>This will serve as a reflection and analysis on the work they have performed.</p>	 <p>A great set up for the situation. If possible, use the book <i>Right and Wrong</i> by all tables from the book, by Marilyn Burns and Gordon Silverman to the class. It discusses recursive patterns, the same and more people are seated and the table arrangements used to give the order or accommodate the number of people.</p>

**EXPRESS YOUR AGE AND NORA AND MAX**

**Express Your Age, Purpose:** To provide practice creating a contextual example of an expression to describe a quantity.

**Launch, Ten or Four?**

- Remind students the expression itself represents the quantity described, so an equation or variable to represent the answer is unnecessary.
- For example, Nora's age can be represented in several different ways and all of them represent the single quantity equal to half her age:
 
$$\text{age} = 2k$$

$$\text{age} = \frac{1}{2} \text{age}$$
- Recognizing that the expression represents the quantity asked for is important for items 6 and 7 in "Nora and Max." See Summary below.
- Students will have different responses for these items. As they share their responses, ask them to share how they found the quantities. For example, if their age is 14, how did they find the answer to item 6? Ask students to represent their given with equations,  $14/2$ , or  $2(14)$ .

**Nora and Max, Purpose:** To extend the practice of representing information or data with numbers to representing quantities with numbers and variables, thereby creating algebraic expressions.

**Launch, Better or First?**

- Ask students to consider that Nora may not want anyone to know how old she is so Nora is using a variable to represent her age in the expressions they are about to write.
- Remind students to use appropriate grouping symbols where necessary to show a quantity as in item 6. This is not "the quantity of a plus two." The parentheses are applied in this expression but are helpful when modeling the expression. See Summary.
- Note there are no equal signs in algebraic expressions, there are none necessary for this page. The expression represents the quantity described.

**Summary:** It is important that students are familiar with and use the phrase "the quantity of..." to talk about the grouping symbols, when modeling expressions. Recognizing the expression as one quantity helps students learn how and when to use the properties of operations to simplify and/or evaluate expressions, particularly the Distributive Property. As students share their responses, be sure they use correct language in modeling their expressions.

**Key Information:** Students may try to create equations for items 6 and 7 such as  $x = 10$  or  $10 = x + 4$ . These are not expressions and introduce a second variable, both of which are not expected or necessary for the task. The expression  $n = 10$  represents Nora's age is 10 years old and if half her age is necessary. In the same way,  $10 = n$  represents the number of years until Nora is 10 years old. Another way to think about this expression is to say "the quantity 10" is the number of years until Nora is 10 years old.

## Poll:

For your student population, how might you prioritize these essential elements as you search for an intervention curriculum?

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Its About Time  
[www.its-about-time.com/aim/aim.html](http://www.its-about-time.com/aim/aim.html)

### Aim for Algebra

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## Next Steps

Archive:  
<http://www.schoolsmovingup.net/webinars/algebra>

Feedback:  
[http://www.surveymonkey.com/s.aspx?sm=X4tPDEM9WgL\\_2fShZwpf7epQ\\_3d\\_3d](http://www.surveymonkey.com/s.aspx?sm=X4tPDEM9WgL_2fShZwpf7epQ_3d_3d)